International Year of Astronomy 2009

— Astrometric VLBI —

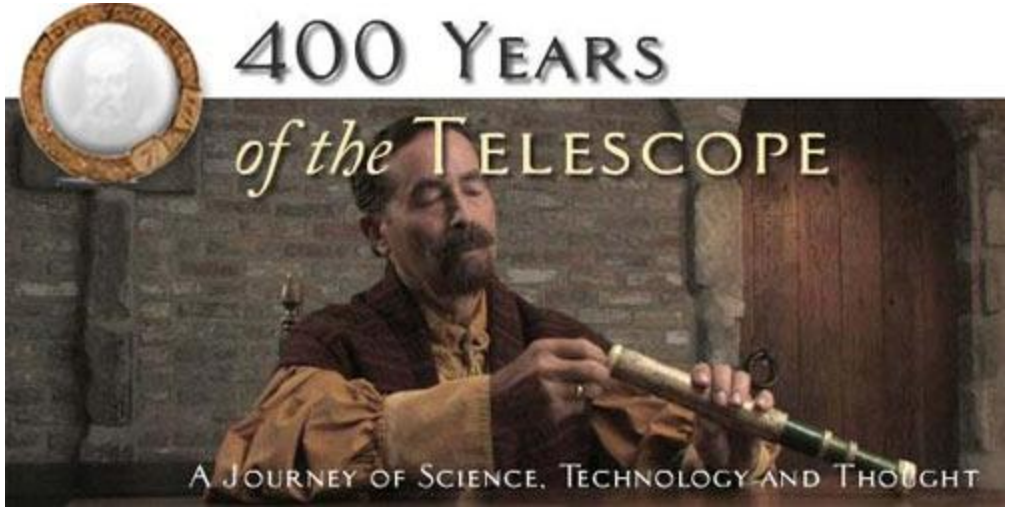
Instrumental revolutions for measuring celestial angles:

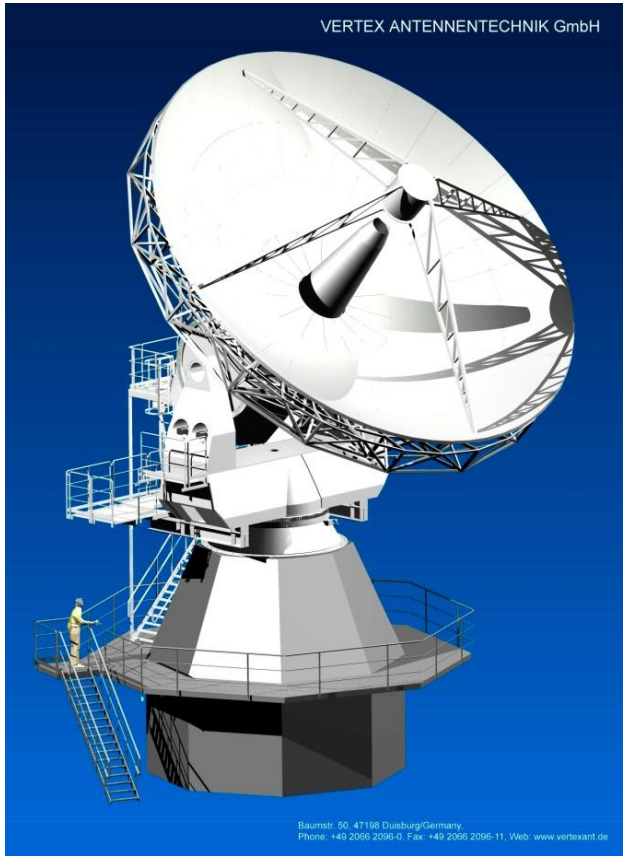
Anniversaries in 2009:
Optical telescope: 400 years / VLBI with radio telescopes: 40 years.

Angular resolution improvement:

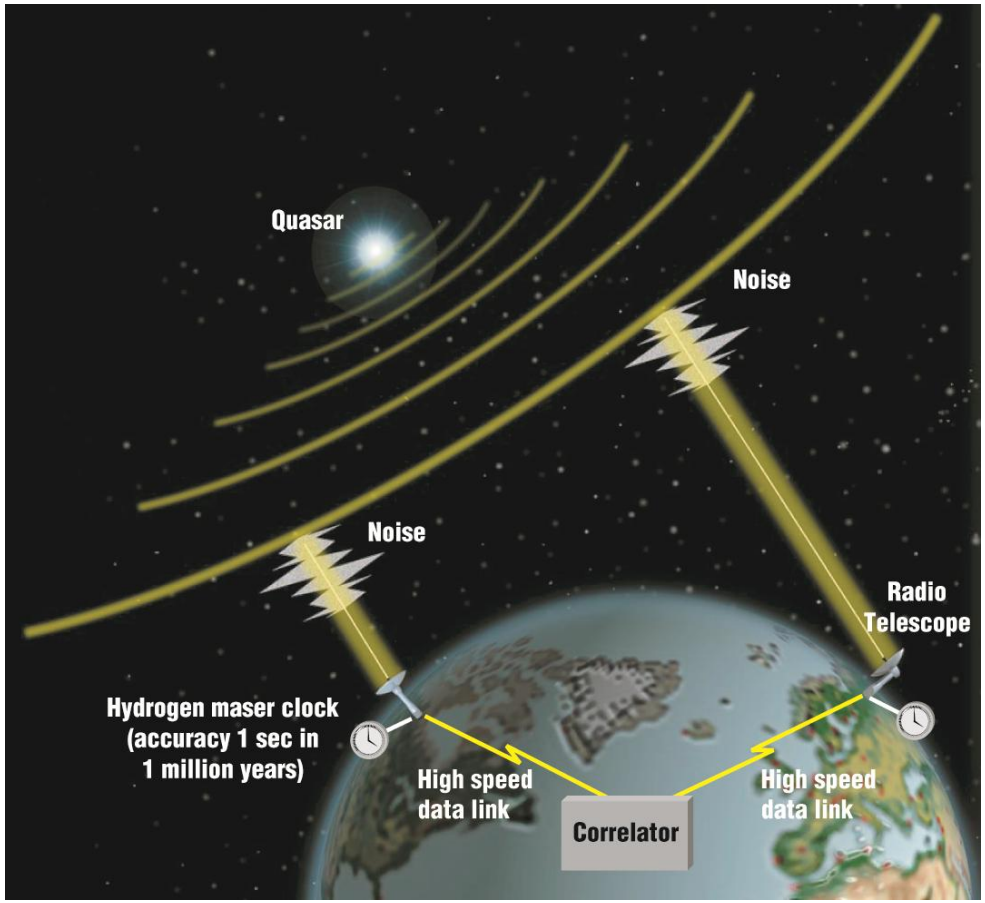
Naked eye:	about 0.0167 degrees
Optical telescope:	0.000278 … 0.0000278 degrees
VLBI with radio telescopes:	0.0000000556 degrees

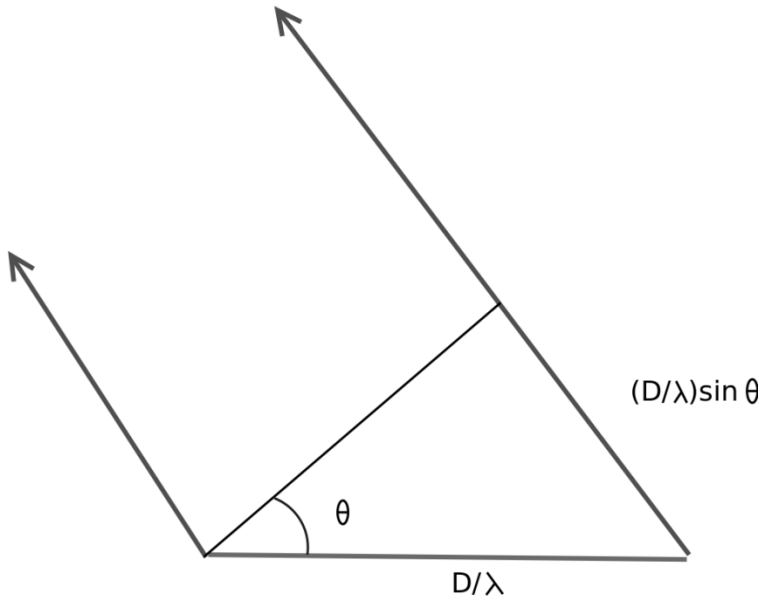
[360 degrees = 1 full circle]





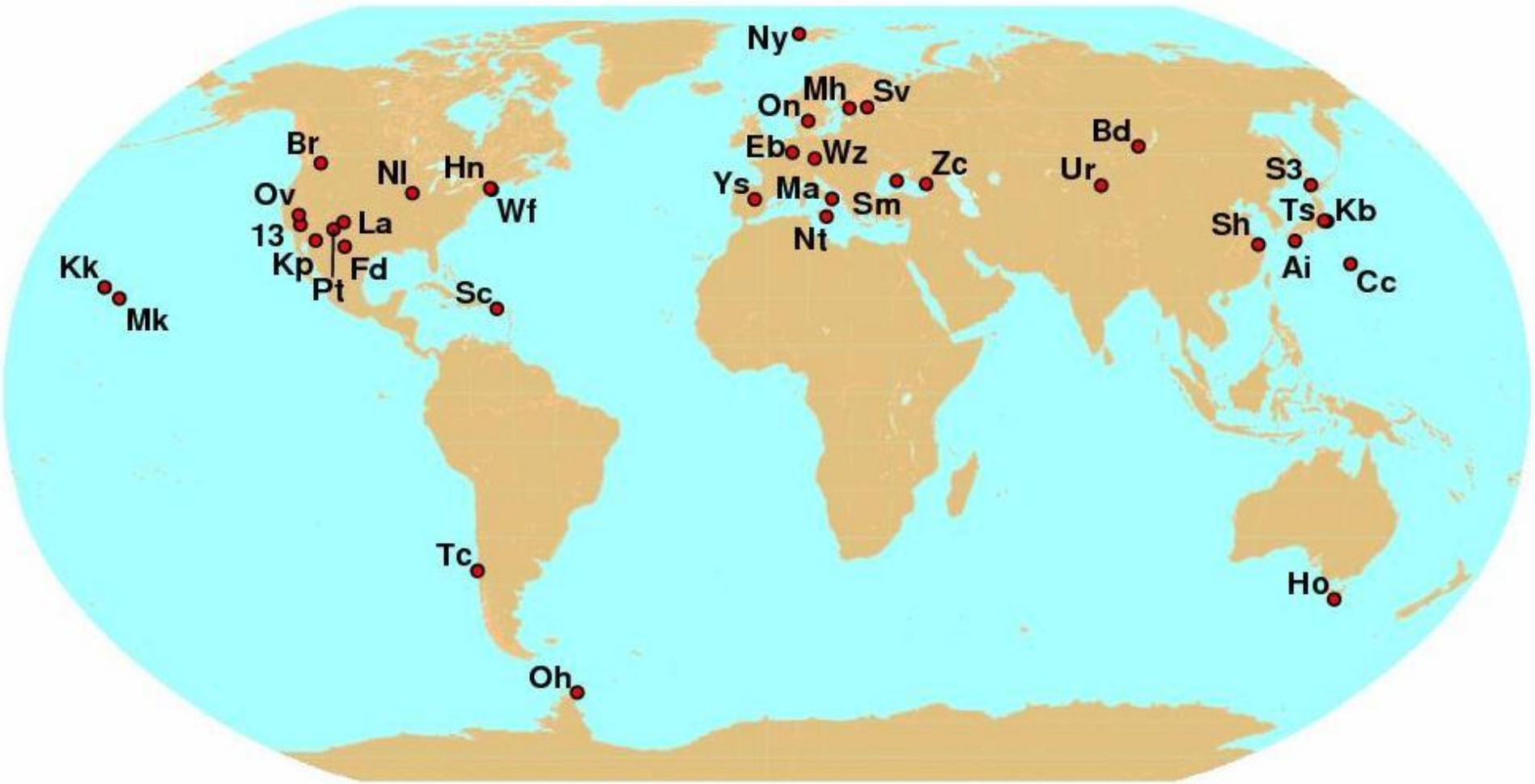
VLBI Concept





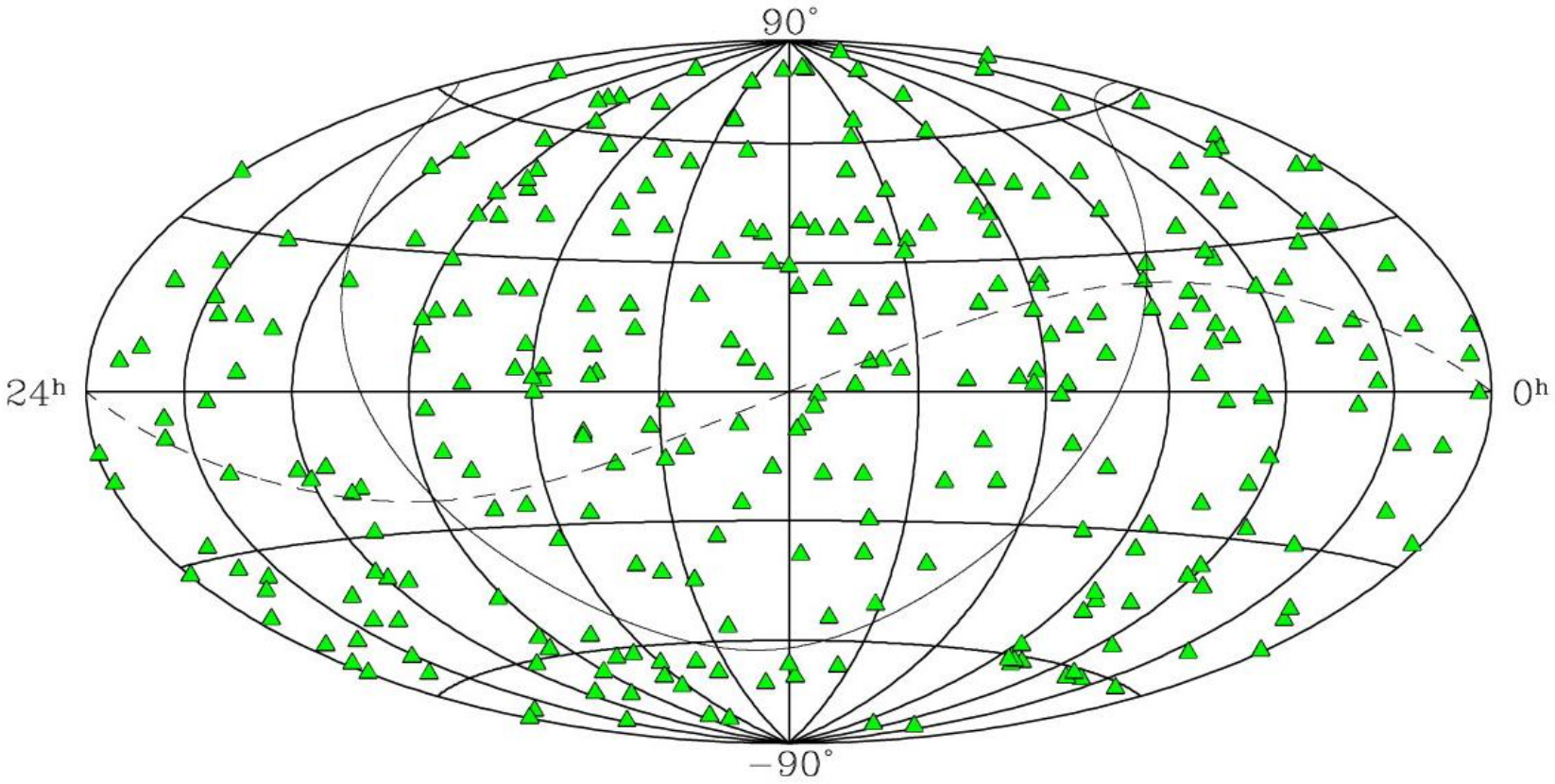
VLBI is a geometric technique: it measures the time difference between the arrival at two Earth-based antennas of a radio wavefront emitted by a distant quasar. Using large numbers of time difference measurements from many quasars observed with a global network of antennas, VLBI determines the inertial reference frame defined by the quasars and simultaneously the precise positions of the antennas. Because the time difference measurements are precise to a few picoseconds, VLBI determines the relative positions of the antennas to a few millimeters and the quasar positions to fractions of a milliarcsecond. Since the antennas are fixed to the Earth, their locations track the instantaneous orientation of the Earth in the inertial reference frame. Relative changes in the antenna locations from a series of measurements indicate tectonic plate motion, regional deformation, and local uplift or subsidence.

IYA09: The Largest Astrometry Session



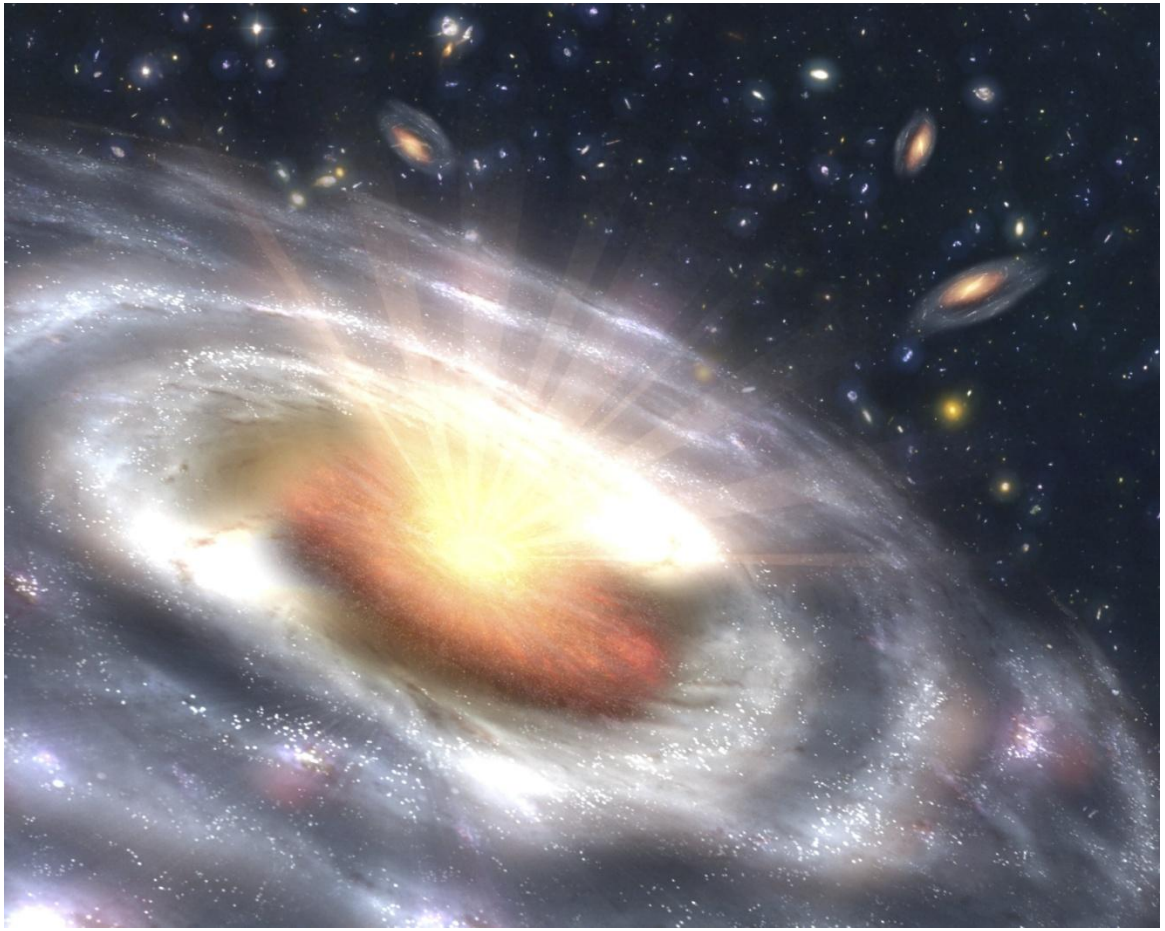
A 35-station network observes the ICRF2 defining sources in a single 24-hour session.

Second Realization of the International Celestial Reference Frame (ICRF2)



- Image shows the 295 defining sources of the ICRF2 on the celestial sphere
- ICRF2 contains precise positions of 3,414 compact extragalactic radio sources
- Sources are typically quasars—very distant extragalactic radio sources
- ICRF2, adopted at the 2009 IAU General Assembly, will replace ICRF1 effective 1 January 2010

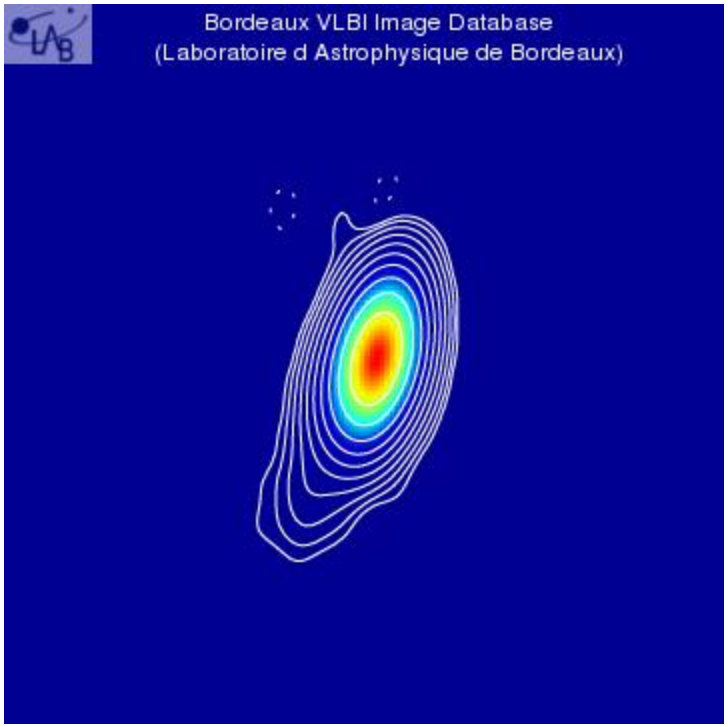
Quasar: a quasi-stellar radio source (1)



Artist's view of a quasar (bright area with rays) embedded in the center of a galaxy. Image courtesy of NASA/JPL-Caltech/T. Pyle (SSC)

Quasar: a quasi-stellar radio source (2)

Quasars are remote objects, typically brighter than a billion suns, which are embedded in the center of galaxies. Scientists believe that these are powered by giant black holes feeding on nearby gas. Gas trapped in the black hole's powerful gravity is compressed and heated to millions of degrees, giving off intense light and/or energy. Most quasars lurk in the outer reaches of the cosmos, over a billion light years away, and are therefore distant enough to appear stationary to us. Quasars make ideal targets to build precise and stable fundamental reference systems for astronomy.



Source 1334-127 on X-band

<u>An ideal ICRF2 radio source:</u>

- radio strong ("bright") object
- pointlike in radio frequencies
- no structure nor time variability
- no apparent motion

Sidenote: *The radio signals from the far distant quasars, which are used to measure the Earth, may be substantially older than the Earth itself.*